

# Electrometallurgical Treatment Technology

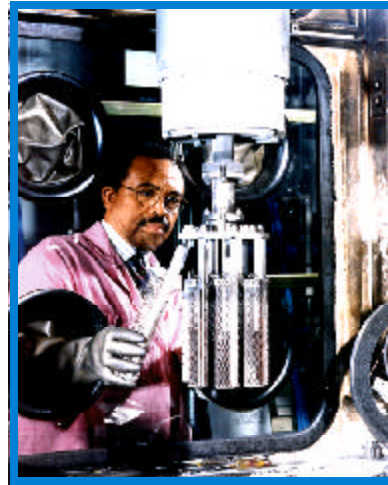
## Background

One of the major challenges facing the Department of Energy, is determining how it can best meet its obligation to disposition the spent nuclear fuel which remains as a legacy of the now shutdown Experimental Breeder Reactor (EBR)-II at the ANL-West site in Idaho.

The EBR-II is a liquid-sodium-cooled test reactor that operated for 30 years, primarily in support of the Department's Integral Fast Reactor (IFR) and other breeder reactor research programs. With the cancellation of the IFR program, the decision to shut down the EBR-II and some smaller support facilities was made in October 1994. The EBR-II spent nuclear fuel and blanket assemblies were removed from the reactor in December 1996, and are temporarily stored in Idaho. This is a metallic fuel with elemental sodium between the uranium fuel pins and the fuel cladding.

The Department is obligated under a settlement agreement with the State of Idaho (the Batt Agreement: resolution of *U.S. vs Governor Batt, Civil No. 91-0054-S-EJL*, reached in October 1995), to manage and prepare this spent fuel for ultimate disposal outside the state, e.g., in a geologic repository. The state of Idaho and others have pointed out that the fuel in this reactor presents a challenging waste management problem. The presence of the sodium makes the EBR-II spent fuel unique. Sodium metal is highly reactive; it burns in air and can explode when exposed to water. Because the sodium is partially absorbed by the uranium fuel elements, mechanical means will not be fully effective in removing it. Therefore, conservative assessments indicate this fuel will have to be treated to create a waste form acceptable for long-term disposal in a geologically-mined repository. Other DOE spent nuclear fuels may also require treatment prior to long-term disposal. Particular attention is being paid to DOE spent fuels in Idaho, since these, along with the EBR-II fuel, must be removed from that state by 2035. The intent is to dispose of these fuels geologically.

An electrometallurgical treatment technology developed at Argonne National Laboratory (ANL) may provide a solution to these treatment and disposal needs, by converting problem spent fuel into a durable ceramic waste product which binds all the plutonium in the fuel along with highly radioactive fission products. This treatment technology **is not a reprocessing technology**, and does not separate plutonium from the fuel. Moreover, rather than producing additional high-level waste streams, this technology results in a significant volume reduction in waste that must be placed in long-term storage, or sent to a geologic repository.



Researcher tests new electrometallurgical equipment at Argonne-West

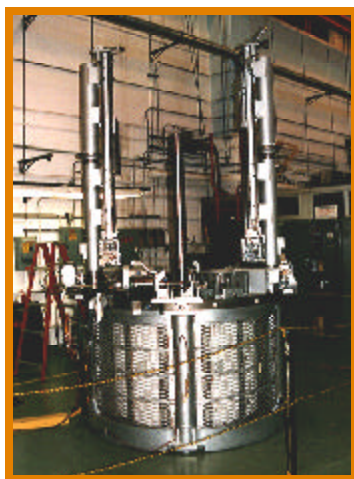
## Program Description

To evaluate this technology and decide how it should be applied, an electrometallurgical treatment technology demonstration program is currently underway. There are two major activities integrated under this program: treatment demonstration and treatment R&D. Electrometallurgical treatment techniques are demonstrated at ANL-West on a small amount of EBR-II spent fuel (about 6.25 percent of the EBR-II spent fuel inventory). Electrometallurgical treatment R&D at ANL-East supports this demonstration by providing experimental data, modeling and analyses needed for full process integration and scale-up to production capacity, and to make any necessary improvements as technical challenges arise in demonstration operations. Both the demonstration and R&D activities are expected to conclude in FY 1999.

The EBR-II demonstration will determine the capacity and reliability of high-throughput treatment, and evaluate the effectiveness of placing plutonium and fission products in the ceramic waste form. Experimental-data analyses and testing of waste forms at ANL-East support the development of demonstration equipment and methods to produce metal and ceramic waste forms having superior consistency, durability and ease of fabrication. Additionally, to permit full characterization of the repository performance of electrometallurgical high-level waste forms, test methods and a performance model are being developed, which will be embodied in a qualification plan.

We will use this qualification plan, in cooperation with the Offices of Environmental Management and Civilian Radioactive Waste Management, to assess risks associated with achieving repository acceptance of electrometallurgical waste forms.

Any future application of this treatment technology in fiscal year 2000 and beyond will be encompassed in another Department program as appropriate.



High-throughput electrorefiner at Argonne-West

### **Independent Program Evaluation**

Activities under the electrometallurgical technology Program are reviewed by the National Academy of Science, which provides its findings and recommendations to the Department in periodic reports and will independently evaluate the program results in a final report to be issued late this year. These reports, which are public information, have recommended that the electrometallurgical treatment technology demonstration be completed. The final report, expected early in fiscal year 2000, will address the success of the demonstration, and the viability of this advanced treatment technology as a solution to the Department's spent fuel management challenges.

### **Record of Decision**

The Department expects to reach a technology decision for the disposition of its sodium-bonded spent nuclear fuel in January 2000. All necessary measures will be taken to ensure this decision is environmentally sound, consistent with policy and law, and cost-effective. This decision will require environmental, as well as other impacts, such as nonproliferation and cost, be assessed and considered.

The Department is preparing an Environmental Impact Statement (EIS) in which electrometallurgical treatment and several alternative technologies will be evaluated and analyzed for their environmental and socio-economic impact. A draft EIS is expected in Summer 1999, and will be made available to the public, as well as other Federal Agencies, American Indian tribes and governments, state and local governments, and all interested parties, for review and comment. Public meetings on this draft document will be held in which all members of the public, including the environmental community, are encouraged to participate. This will be an open and fair process that provides meaningful opportunities for the public to obtain information and provide comment. The Department will carefully consider and address all comments in its final EIS.

Separate reports will also assess the cost and nonproliferation impacts of applying each of the technology alternatives being considered in the EIS to the disposition of sodium-bonded spent nuclear fuel. These, along with the EIS, National Academy of Science reports, and any other necessary information, will be factored into the decision-making process.

### **FY 1999 Planned Accomplishments**

- Complete the electrometallurgical treatment technology demonstration program;
- Develop sufficient R&D data to support preparation of the EIS, and to ensure timely evaluation of the EBR-II demonstration by the NAS. Data will include final high-throughput inventory operating parameters, results of electrorefiner corrosion studies, and process integration model analyses;
- Implement waste form qualification plans and performance models; and
- Complete sufficient testing to make an informed assessment of waste form performance, and to support a DOE decision on future use of electrometallurgical treatment; complete preliminary design study on waste packaging.

Program Budget (in millions)			
	FY 1998 <u>Appropriation</u>	FY 1999 <u>Appropriation</u>	FY 2000 <u>Request</u>
Electrometallurgical R&D	\$ 20.0 <sup>1</sup>	\$ 20.0	Complete
EBR-II Demonstration	25.3	25.0	Complete

<sup>1</sup> The \$20 million identified in FY 1998 is provided under two separate accounts: \$12 million for Nuclear Technology R&D under Other Defense Activities, and \$8 million for Termination Costs under Energy Supply R&D (both under Energy and Water Development Appropriation Act).